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6

Long-Term Vegetation Changes in the Near East

NAOMI F. MILLER

The Near East has the longest tradition of permanent settlement in the world, and there is a corresponding history of population fluctuation, technological development, and human-induced environmental change. For example, by settling down in one place, the earliest villagers of 12,000 years ago provided a new niche for a variety of odious organisms, from microbes to mice. People altered the landscape when they began planting crops about 10,000 years ago, a process that accelerated with the establishment of farming and herding. The vegetation cover, as well, has undergone continuing change, thanks to extensive fuel-cutting and the introduction of new plants, both cultivated and weedy, from beyond the borders of the Near East. Even the massive water control projects we see today, from the dams along the Tigris and Euphrates Rivers to the draining of the lower Mesopotamian marshes, have their precedents in the history of the Near East.

Agriculture began as a small-scale enterprise that had only locally manifested environmental effects. Its great success in supporting high population levels encouraged agricultural practices to spread to many different regions. Sooner or later, depending on the intensity of land use and the fragility of local conditions, it led to widespread vegetation changes. Cultivation, of course, disturbed the soil directly and expanded the area of some plants at the expense of others. Animal grazing and fuel-cutting affected the nonfarmed land as well. In the Near East, the cumulative result of these activities has altered not just the vegetation but the land itself. With deforestation on the mountainsides, valleys fill with sediment. At first this might expand the area of farmland, but deforestation leads to permanent soil loss on the slopes and reduces the ability of the land to absorb water, which, in turn, lowers the water table.

The dramatic long-term effects of these land-use practices are still with us. This chapter discusses evidence of how human activity has altered the vegetation of the Near East over the millennia and briefly considers the role of climate fluctuations in vegetational history.

A common image of the Near East is a desert with a few camels. In fact, physical conditions support dense forests as well as barren deserts (Figure 6.1) (Zohary 1973). Cultural practices, too, influence the total picture. History has seen the rise and fall of several civilizations in the Near East. Even over the past 500 years travelers passing through a single territory sometimes report radically different landscapes,

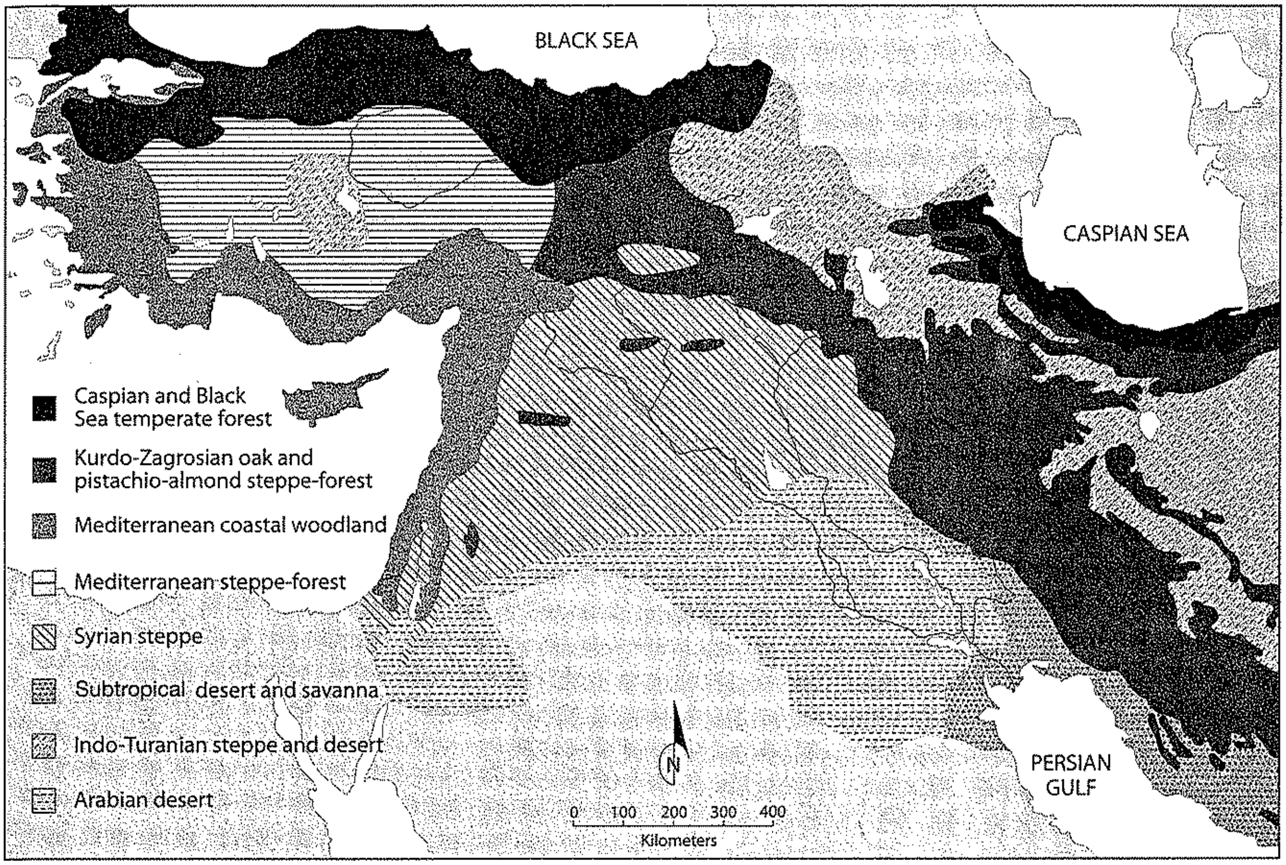

Figure 6.1. Vegetation map of the Near East.

because land reclamation projects and improved social conditions have occasionally restored prosperity to regions that in other periods had been impoverished (e.g., Kortum 1976). This means that the intensity and rate of change in any particular place depends on many factors, including the resilience of the local environment, its location with respect to centers of population and industry, population density, and the level of technology. In fact, environmental degradation that can be traced in the archaeological record tends to be associated with periods and places of high population and intensive fuel-consuming activities (Miller 1990a).

The First Farmers

The first evidence for virtually year-round settlement dates to about 12,000 years ago, the Natufian period in the Levant and Epipaleolithic elsewhere. Plant cultivation does not seem to have begun until 2,000 years later, in the Jordan Valley, whence it spread northward and eastward along the edge of the Syrian desert (van Zeist 1986). At around 6000 B.C. in Syria, western Turkey, and the Levant, domesticated sheep and goats first became integrated into the mixed pastoral economy that persists, with modifications, to this day.

The adoption of animal husbandry had a significant effect on the vegetation of southwest Asia, especially on the steppe. When gazelle roamed the Syrian steppe at the beginning of the Holocene, it was under somewhat moister conditions than prevail today (van Zeist and Bottema 1991:101), and the vegetation consisted of many edible plants (Hillman and de Moulins 2000). The vegetation available to the Epipaleolithic hunters of Abu Hureyra included species that were replaced by weedy taxa after farming began (Hillman and de Moulins 2000) (Figure 6.2). Van Zeist and Bakker-Heeres (1985[1988]:286) reach a similar conclusion. Farming expanded the habitat for plants that occupy disturbed ground, and after domesticated sheep and goat were introduced, grazing pressure increased. The end result was the degradation of grazing lands characteristic of much of the Near East today. These changes are reflected in seed assemblages from a wide area. Over time, preferred fodder plants decline and minor components of the original vegetation, such as bitter-tasting wild rue (*Peganum harmala*) and spiny camelthorn (*Alhagi* sp.), start appearing in archaeobotanical assemblages in the Euphrates Valley and elsewhere. Wild rue and camelthorn do not occur at the early villages, but they show up routinely in sites of the early civilizations of the third millennium B.C. and later (Miller 1991).[1]

Other effects of the settled life on surrounding vegetation are apparent at sites as early as 6000 B.C. (Köhler-Rollefson 1988). Pre-pottery Neolithic villagers living at 'Ain Ghazal at the edge of the Syrian steppe herded goats and grew cereals and pulses. Though they did not produce pottery, they did need fuel for making tons of plaster for buildings and objects. They also periodically rebuilt their houses; over time, the diameter of the post holes got smaller and less wood was used in the buildings. These factors affected the woody vegetation: People cut down large, old trees for fuel and construction, and new tree growth was hindered by goat browsing (Köhler-Rollefson 1988). Desertification in the vicinity ultimately caused people to abandon the site.

The Environmental Impact of the Early Civilizations in the Taurus-Zagros Arc

In the upland areas, which include the "hilly flanks" of the Zagros Mountains, the natural plant cover is steppe-forest and forest. People living there had wood to burn, and indeed the main component of flotation samples is typically wood charcoal. As might be expected, however, many settled populations cut wood for fuel at a faster rate than it could regenerate locally. Expansion of agricultural and pastoral production to feed growing populations also took its toll on the vegetation.

One place where it is possible to trace the long-term effects of these activities through wood charcoal and seed analysis is the site of Malyan (ancient Anshan) in the Zagros Mountains in southern Iran (Miller 1984, 1985). Malyan was a walled city, by far the largest settlement in the region. Survey data and ethnographic analogues for population density indicate that Malyan housed about 6,400 people at 3000 B.C. (about two-thirds of the valley's population), and 19,800 at 2000 B.C. (almost half the valley's population) (Sumner 1986, 1989).[2] These population levels were not again reached until Islamic times (Sumner 1972).

A number of land-use practices and technologies stressed the forest vegetation. Feeding people and their flocks promoted a certain amount of land clearance, as did satisfying fuel requirements for household cooking and heating. Small- and large-scale industrial processes like ceramic and plaster manufacture and metal smelting consumed even more fuel. Even if per capita use of pottery, plaster, and metal had remained unchanged, population increase would have put additional pressure on the vegetation (see Blackman 1982; Nickerson 1983).

Malyan lies on the border between the drier pistachio-almond forest and the moister, cooler oak forest zones. Juniper, a component of the original forests, was virtually eliminated by 2500 B.C. In fact, ancient texts from this time concerning "the land of the cut-down ERIN-trees" most probably refer to juniper cut from the forests of the Zagros Mountains (Hansman 1976). Even the pistachio and almond were cleared from near the city, and people had to collect fuel from further afield, in the oak forest (Miller 1985). After depleting their local wood supply, the people of Malyan increasingly turned to the world's first alternative energy source: animal dung. Livestock ate plants; at least some seeds were consumed and then expelled in the dung, which people collected and burned. Archaeologically, between 3000 and 2000 B.C., the proportion of charred seeds relative to charred wood increased 10-fold. That is, dung became a more important fuel source and seems to have replaced local sources of wood. In the charred seed assemblage, barley vastly outnumbers wheat, by about 13 to 1. As is true today, it would seem that barley was the preferred fodder. Unexpected corroboration for this interpretation came from a cess deposit filled with mineralized seeds. Unlike the charred assemblage, wheat grains outnumbered barley by about 2 to 1, reflecting human rather than animal dietary habits (Miller 1984).

Analogous vegetation changes occurred in areas on the periphery of Mesopotamia during the third and second millennia B.C. For example, the archaeobotanical assemblage from Kurban Höyük (southeastern Turkey), like Malyan's, shows an increase in the seed:charcoal ratio, which points to a reduction in tree cover in the latter half of the third millennium B.C. (Miller 1990a). Similarly, pollen cores from Lake

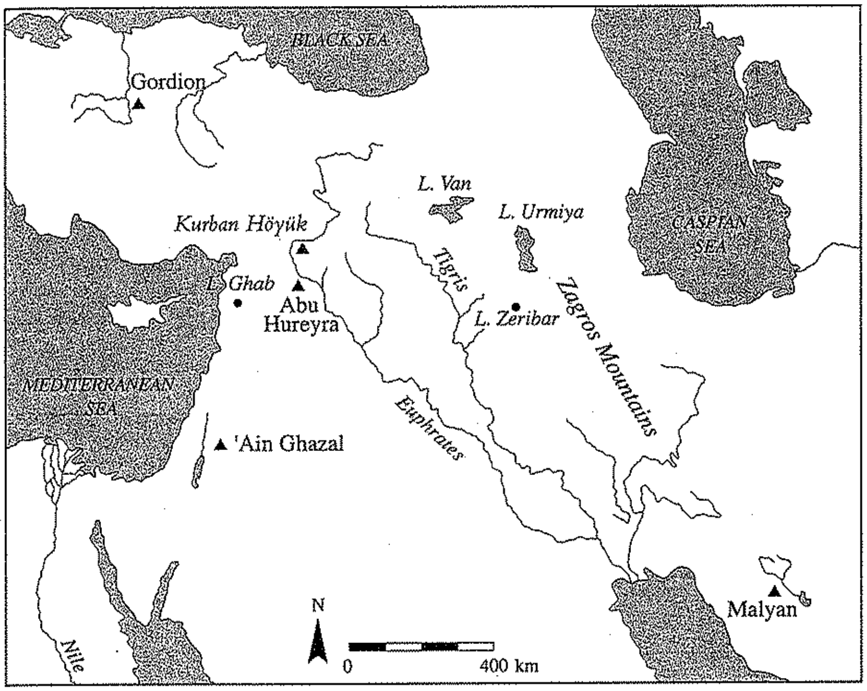

Figure 6.2. Sites mentioned in text.

Ghab, Syria (van Zeist and Bottema 1991:101) show evidence of human disturbance about this time.

A VIEW FROM THE ANATOLIAN IRON AGE

Gordion is the purported home of the Phrygian King Midas. All of the types of archaeobotanical evidence for vegetation change just mentioned can be seen there: beam diameter, wood choice, seeds of noxious plants, and dung fuel.

Gordion is best known for its Phrygian period settlement of about 700 B.C. and nearly 100 contemporary earthen burial mounds nearby. The largest of these, Tumulus MM, rises 53 meters above the modern plain. University of Pennsylvania excavations directed between 1950 and 1974 by Rodney Young and at present by Mary Voigt uncovered a large area, including the royal precinct and associated service buildings.[3] These latter buildings were about 15 meters wide and had massive pine roof beams, which we know because around 700 B.C. there was a conflagration in the central part of the site. Soon after the destruction, people laid a couple of meters of clean clay over the central precinct, and rebuilt on top of it. This time, the palace buildings were a little smaller, and the service buildings were 3–5 meters narrower. Another burned building was found in a later Hellenistic level; it has a more residential character, and is narrower still (3.5 meters). Although pine continued in use for construction, the shortening of the roof beams suggests that the tall old pine trees were gradually being eliminated from the forest.

Contemporary with the palace precinct structures, Tumulus MM was built over a log tomb that measures about 6.2 meters by 5.1 meters by 3.5 meters, probably the oldest standing wooden structure in the world (R. Liebhart, pers. comm.). The tomb chamber contained a body on a wooden bier, other well-preserved wooden furniture, a number of bronze and ceramic vessels, and other burial goods (Young 1981). The walls are made of massive pine and juniper beams (Kayacık and Aytuğ 1968).

The effort involved in transporting timbers to the urban and mortuary construction sites would have been substantial even if the trees grew nearby, and we do not even know just how close the forest was. In the valley today, untended trees are a rarity away from the river. The modern plant cover nonetheless provides the first clues for reconstructing the composition and distribution of the ancient vegetation in more detail.

Gordion lies at the upper edge of the central Anatolian steppe. There is a small remnant of relatively intact

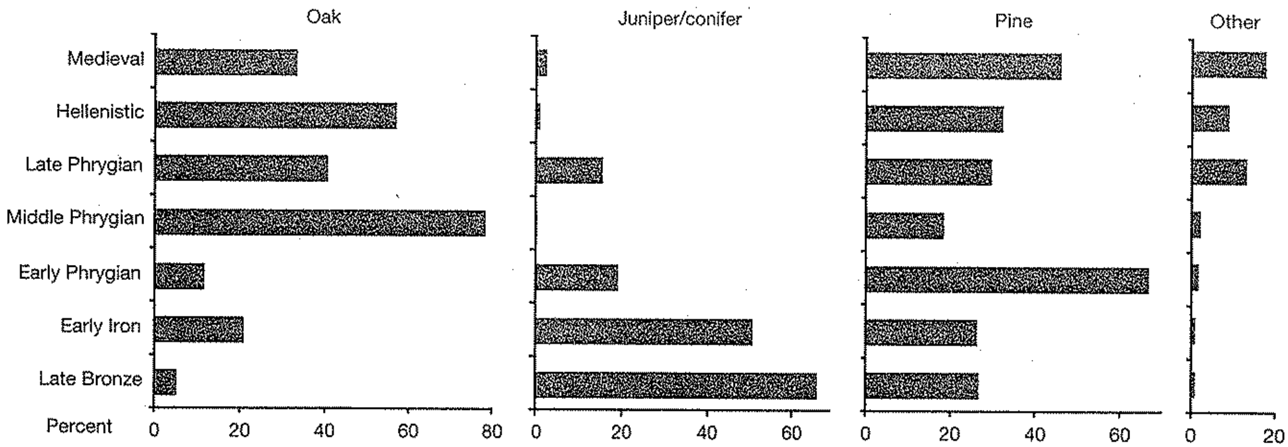

Figure 6.3. Major fuel charcoal types from Gordion (based on weight in grams, extrapolated from total sample weight). Total weight (g) and number of identified pieces: Late Bronze (75.61; 13), Early Iron (183.80; 52), Early Phrygian (28.57; 16), Middle Phrygian (53.73; 8), Late Phrygian (235.86; 71), Hellenistic (118.56; 36), Medieval (20.38; 12).

grassland about 5 kilometers from the site. About 10 kilometers away, a few hundred meters higher in elevation, scrub juniper and oak begin to make an appearance. It is not at all clear how tall these trees could grow if they were left undisturbed by wood-cutters and the local herds. About 25 kilometers from the site are a few huge junipers that are virtually identical to the tomb timbers. In the higher mountains there is a closed-canopy pine forest with an understory of oak and juniper. Precipitation, which tends to increase with elevation in this part of Turkey, constrains tree growth, as do other natural factors, like the soil substrate. For example, juniper seems to do better than oak on gypseous soils, but the opposite is true for basaltic soils (pers. obs. with B. Marsh). On uncultivated land, grazing and fuel-cutting are still major influences on vegetation in rural areas like this one.

In antiquity, building required a certain amount of wood, but economic factors limited the use of massive timbers to fairly restricted elite purposes. In contrast, fuel was consumed by rich and poor alike. Because wood is bulky, fuel preferences depended largely on transport costs. Especially in the absence of mechanized transport, fuel choice tends to reflect local vegetation, whether the fuel came directly from woody species or in the form of dung. It is a fair assumption that the charred wood remains from Gordion occupation debris (as opposed to the burned buildings) were originally burned for fuel.

Not surprisingly, the species distribution in charred remains of trash differs from that of building materials (Miller 1999). Furthermore, the sequence based on occupation debris is more complete because it does not depend on serendipitous finds of burned buildings; for example, oak is absent from the construction remains but is common in trash. The overall pattern of wood fuel use is illustrated in Figure 6.3.[4] Some explicable patterns are apparent. First, through the Medieval period, major forest woods of the region—juniper, oak, and pine—were readily available. The category "other" consists of types that grow near the river (e.g., poplar) or in forest clearings and agricultural fields (e.g., hawthorn and elm). The gradual increase in these secondary types suggests the primary forest cover suffered a slow but steady reduction. Figure 6.3 also suggests that oak replaced juniper. This is not unexpected because juniper is a very slow-growing, arid lands tree, which probably was a convenient source of fuel early on. It is noteworthy that by about 700 B.C. people had exhausted the supply of juniper fuel, but the closest timber-quality trees were reserved for elite burial. As at Malyan, juniper could not recover as readily from heavy cutting as oak. Pine use seems relatively steady over time, except for the charcoal from the not strictly comparable construction debris in the Early Phrygian courtyard. In summary, the charcoal evidence suggests people fueled fire with the primary forest woods through the Medieval period, though there was some permanent loss of forest cover.

Convenience probably dictated at least occasional use of dung and possibly brush to supplement the wood fuel sup-

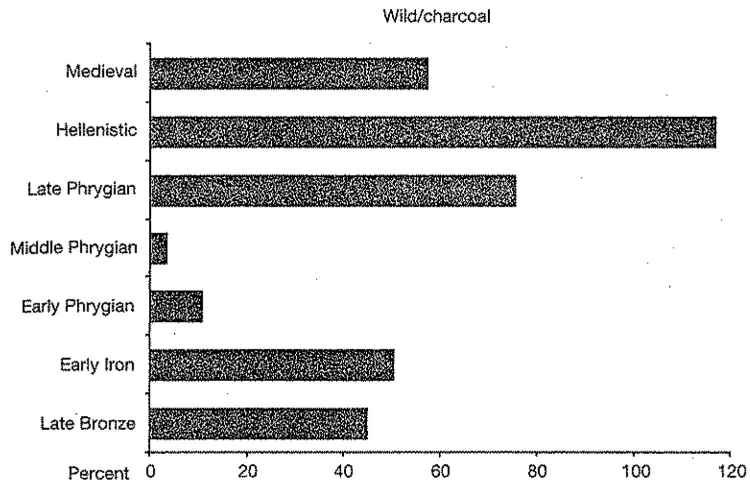

Figure 6.4. An indicator of dung fuel use: ratio of the number of seeds of wild plants to the weight of charcoal. Chart is based on the average wild/charcoal ratio for each period. Number of flotation samples: Late Bronze (32), Early Iron (40), Early Phrygian (7); Middle Phrygian (15), Late Phrygian (53), Hellenistic (29), Medieval (15).

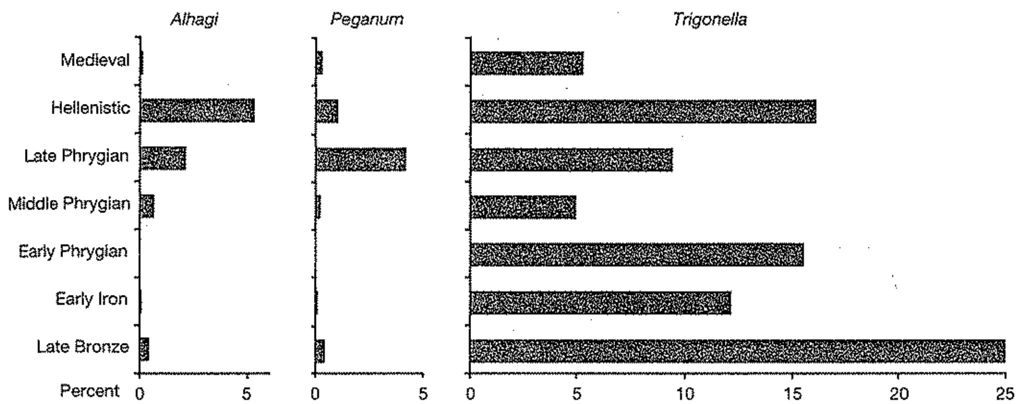

Figure 6.5. Indicators of pasture quality. *Alhagi* (camelthorn) is spiny, *Peganum* (wild rue) is unpalatable, *Trigonella* provides good forage. Chart is based on total seed count for each period. Number of flotation samples and total number of wild seeds: Late Bronze (32; 5,060), Early Iron (40; 7,711), Early Phrygian (7; 64), Middle Phrygian (15; 439), Late Phrygian (53; 10,173), Hellenistic (29; 7,463), Medieval (15; 2,843).

ply, as suggested by the ratio of wild seeds to charcoal and the proportion of types avoided by animals—wild rue and camelthorn (Figures 6.4 and 6.5). These three measures support the view that wood fuel use declined somewhat in the later part of the sequence (Figure 6.4). The regional survey directed by Lisa Kealhofer may help us determine whether or not pressure on fuel resources is associated with changes in population density.

The herding of sheep, goat, and cattle is another important variable that leaves traces in the archaeobotanical record. Insofar as charred seeds come from dung fuel, they provide evidence for fodder and changes in the quality of pasture. Archaeologically, we can examine the distribution of wild seeds relative to cultivated ones as a way to monitor the relative importance of pastoralism over agriculture (see Miller 1997b). Figure 6.6 plots the ratio of the number of wild seeds to the weight of large seed fragments, mainly cereals and pulses. It suggests that pastoralism was most important at the beginning and end of the sequence. A particularly abundant seed, *Trigonella,* allows us to assess grazing pressure. *Trigonella,* a tasty (if one is a sheep or goat) clover-like legume, is an indicator of high-quality pasture. Therefore, the proportion of *Trigonella* in the wild seed assemblage allows one to monitor the intensity of grazing. With allowance for the small Early Phrygian sample, the distribution of *Trigonella* parallels that of wild seed:crop ratio until the Medieval period (Figure 6.5)—when *Trigonella* seems to have become less prominent in the vegetation. That is, even though pastoralism appears to have been very important at the end of the sequence, pasture quality declined.

A geomorphological study by Ben Marsh (1994) supports this general picture. Over 4 meters of sediment eroded fairly rapidly from the hillsides to the east of the valley. This was probably the result of fuel-cutting exacerbated by overgrazing in post-Hellenistic times. What is different about this

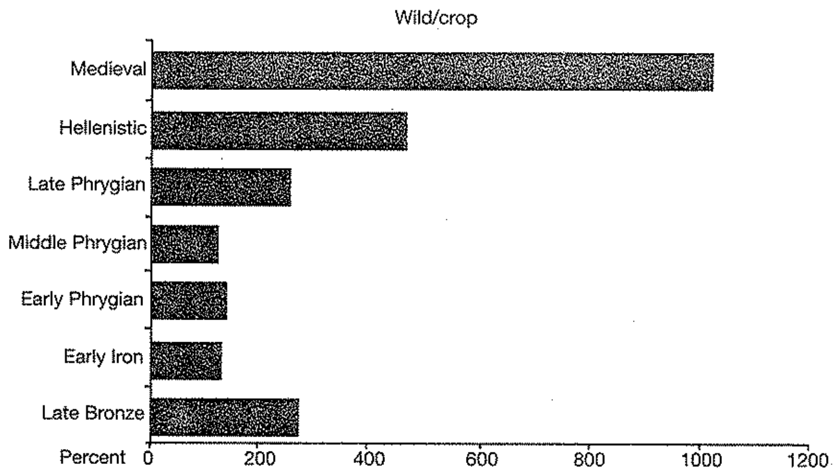

Figure 6.6. An indicator of fodder sources: ratio of the seeds of wild plants to those of crop plants. Chart is based on average wild/crop ratio for each period. Numerator is the number of wild seeds; denominator the weight in grams of the seed material larger than 2 millimeters, primarily cereals and pulses. Number of flotation samples: Late Bronze (32), Early Iron (40), Early Phrygian (7), Middle Phrygian (15), Late Phrygian (53), Hellenistic (29), Medieval (15).

most recent time of intense land use is that soil loss from the hillsides is irreversible, so reforestation would be difficult if not impossible in most areas.[5]

Archaeologists enjoy the luxury of tracking change over millennia. We can be confident, however, that people have always been aware of short-term changes in the landscape in their immediate neighborhood. By the third millennium B.C., even Mesopotamians who had never been to the Zagros Mountains might have heard about "the land of the cut-down ERIN-trees." In the first millennium B.C., the Assyrian kings were bringing foreign plants directly from conquered territory into their gardens, as they consciously manipulated the landscape for symbolic as well as aesthetic reasons (Miller 1990b). I do not usually bring my discussions up to the present, but the subject of the symposia on which this volume is based inspired me to consider recent changes around Gordion and how one might use the information we have collected to envision the opportunities that a restored steppe landscape could bring.

In 1957, the Turkish General Directorate of Soil and Water Works straightened and deepened a short stretch of the Sakarya River near Gordion. The river is by nature meandering, and it used to flood the plain annually for two to three months every spring. When I asked an acquaintance what the area had been like before the channelization, the first thing he mentioned was that in the old days there used to be more mosquitoes. He added that there were also a lot more plants then, so flocks grazed on the floodplain. Even in the past decade there have been noticeable changes in land use because a government development project has made water more available. Because it is profitable, the farmers have been growing more sugar beets and onions even though these crops are not particularly suited to the semiarid natural conditions. In addition, economic forces that operate at a scale far beyond the village lure young people to the cities. The net effect on the local economy is that fewer shepherds take care of the same flocks, some common grazing land has been lost to crop production, and animals are increasingly fed purchased fodder (A. Gursan-Salzmann pers. comm.).

The traditional economy based on herding and farming may no longer be viable, and the archaeological analysis suggests that it will never be possible to fully restore the natural vegetation. Even so, it would be worthwhile to try to reestablish grassy steppe vegetation at least on the archaeological mounds. This would be particularly important for the major burial mounds, such as Tumulus MM, to prevent erosion if nothing else (Miller 2000). Botanical and archaeobotanical surveys suggest which plants might be encouraged. Being able to view the archaeological sites within even a partially restored landscape could have tremendous touristic value, which in turn could bring a different sort of economic vitality to the region.

WHAT ABOUT CLIMATE?

By the fourth millennium B.C., local expressions of the basic Near Eastern agropastoral subsistence system were well established (Miller 1991, 1997a). Modern vegetation patterns in the Near East have been fairly stable for about 4,000 years (van Zeist and Bottema 1991). Precipitation is and was a major limiting factor for agriculture. At least some of the variation in agricultural practices reflects precipitation clines and can be recognized in the archaeobotanical record. For example, barley tends to be more drought-tolerant than wheat, and its importance seems to increase as one goes south, into the drier parts of Mesopotamia. Similarly, sites at the northern edge of Mesopotamia show much greater dependence on cultivated fodder crops than those at the edge of the steppe (Miller 1997b), where vast areas of natural pasture can support large herds.[6]

We know that short-term climate fluctuations can affect settlement and subsistence, especially in regions that are environmentally marginal for the available level of technology. Examples include the archaeologically traceable effects on settlement patterns in the southwestern United States during periods of drought (Minnis 1985) and historical documentation of the Little Ice Age (1550–1900) in Europe (Lamb 1982). It would seem logical that such forces could be at work in the Near East, as well. To understand the effect of climate fluctuations in any given cultural period, however, several questions need to be addressed: (1) Did the climate change? (2) How much and in what way? (3) Was the change sufficient to disrupt the ordinary adaptive responses to normal annual and interannual climate variation? As Minnis (1985:19) points out, *"The magnitude of responses should match the severity of the perturbation."*

In theory, climate change may either slow down or intensify the effects of human land-use practices. It must be remembered, however, that whether climate changes are favorable or deleterious, they influence but do not cause particular responses on the part of human populations. As archaeologists, we would like to know the intensity of an environmental disturbance, but the more interesting question is whether a society had the cultural adaptive mechanisms to respond to it.

The impact of Holocene climate fluctuations on the natural vegetation of the Near East cannot be dismissed, but neither is it obvious. The uncertainty stems partly from the fact that the evidence for ancient climate is inferred from "proxy data," nonclimatic sources such as the pollen record and geomorphological evidence, which in turn reflect vegetation more directly than they reflect climate. For example, it took time for plants requiring relatively warm, moist conditions to colonize newly opened habitats after the cold aridity of the Pleistocene was lifted, so interpretations of the pollen evidence must take this time lag into account. Indeed, this complicates the interpretation of the Malyan assemblage. As already discussed, I think it most likely that oak forest grew on the north end of the valley during the entire occupation of the site, despite the paucity of oak charcoal in the deposits of the late fourth millennium. Yet post-Pleistocene oak forest did not reach the central Zagros from northern regions until about 4250 B.C., and Malyan lies 750 kilometers farther away to the southeast. In the case of the Malyan plant remains, therefore, the slow spread of oak climax forest cannot be totally ruled out as an explanation for the low oak charcoal quantities in the earlier period.

Recently, settlement histories and soil micromorphological evidence have been applied in northern Syria to infer a rapid onset of drought so severe that it caused the collapse of the Akkadian Empire and most of the adjacent civilizations at about 2200 B.C. (Dalfes et al. 1997; Weiss et al. 1993). There is room for disagreement because the proposed natural environmental disaster occurred during the florescence of the great urban civilizations of early Mesopotamia, when growing populations and fuel-intensive industries were expanding to an ever-widening area (see Zettler 1997:n. 4).

Much of the evidence for drought more directly reflects loss of vegetation cover than climate deterioration: deforestation, soil erosion, and subsequent lowering of the water table. Drought-induced deforestation would have taken decades to affect the fuel-gathering economy, but farmers and herders could have brought a range of traditional adaptive strategies into action right away to ensure adequate food supplies. Farmers might plant more drought-tolerant cereals, in which case barley might become a more favored crop. They also would be more likely to send their animals out to pasture, in which case pasture plants might become more significant relative to cultivated fodder. Contrary to predictions of the drought theory, however, the proportion of wheat to barley is fairly constant and the proportion of wild plant seeds to cultivated ones actually falls a bit between the mid-third and late third/early second millennia B.C. in at least one site within the affected region, Kurban Höyük (Miller 1997b).[7]

Another reason it is not obvious that severe drought at about 2200 B.C. had a big impact on human populations in the Near East is that in areas peripheral to the developing urban civilizations the pollen record is inconsistent with the hypothesis of widespread aridity. Pollen cores from the Taurus Mountains of eastern Turkey show an expansion of arboreal vegetation during the fourth millennium B.C. The forest reached its maximum at about 3000 B.C. and was maintained for two more millennia. In contrast to the evidence from northern Mesopotamia and southern Iran, the forest does not seem to have been adversely affected until about 800 B.C., the time of the empire of Urartu (van Zeist and Bottema 1991:61–64), when that area was undergoing tremendous economic development, and mineral wealth of the mountains was extensively exploited for a variety of weapons, tools, and other objects (Piotrovskii 1967). The territory of Urartu is characterized by a cool climate and relatively high precipitation that leaves the region snow-covered for several months a year. An ethnographic analogy suggests that agriculture is most effective when combined with animal husbandry that can take advantage of high summer pastures. Ancient texts mention impressive fields and flocks (Zimansky 1985), and the agricultural and material prosperity of Urartu impressed the Assyrian king, Sargon (Oppenheim 1960). In addition, the movement of large numbers of people is recorded in king lists (Zimansky 1985).

Evidence for changes in population levels is indirect at best, and population densities are extremely difficult to estimate. Most of the archaeological data analyzed to date come from hilltop fortresses with vast storage capacities but limited sherd debris (Zimansky 1985). One archaeological survey within Urartian territory suggests an influx of people at around 3000 B.C., followed by a population decline. By the Urartian period, settlement does not appear to have been any larger than in earlier times (Rothman 1992; Rothman and Kozbe 1997). In the Urartian case, therefore, neither climate nor high human population density seem to be major factors in vegetation change. Rather, the demands of the metal industry or pastoral production better account for the loss of trees recorded in the pollen record.

In short, one of the reasons it is so hard to isolate climate fluctuations in the Near East is that dramatic vegetation changes during the early years of history were largely a product of human land-use practices, which in turn were determined by population density and the requirements of wood- and fuel-intensive industry. The Near East was never a "Garden of Eden," and the present state of vegetation is a result of the interaction of "natural" and "cultural" processes. People conduct their daily lives within a natural environment that has its own, sometimes unforgiving, qualities, and land-use practices that favor short-term economic advantage over long-term, sustainable resource management may adversely affect later generations. If archaeology has a lesson, it is that change is inevitable, but individuals and governments can choose the direction it takes.

Endnotes

Note: Calibrated radiocarbon dates are used in this chapter.

1. It is no accident that so many field weeds in North America are of Eurasian origin; having evolved through millennia of farming and grazing in the Middle East and Europe, they compete particularly effectively against native North American species in fields and other disturbed habitats.
2. About 40 hectares of the site was occupied at the beginning of the third millennium, and 130 hectares at the end, though the total walled area is over 200 hectares. Archaeologists working in the Near East generally estimate about 100–200 people/hectare of occupied site.
3. For information on the earlier and current excavations, see references in Voigt (1994).
4. The Early Phrygian charcoal distribution is anomalous because it probably consists primarily of construction debris within a courtyard area rather than domestic or industrial trash (M. M. Voigt, pers. comm.).
5. Working in central Greece, Bintliff (1982:157) attributes a similar sequence of massive erosion in post-Classical times to climate deterioration. See the next section for a discussion of climate change.
6. The ratio of wild seeds to cultivated grain in dung used as fuel tends to be higher in more arid territory.
7. Note, too, that 2200 B.C. also marks the onset of an important period of agricultural and population growth around Malyan, discussed earlier.

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